

Changing Large-Scale Collaborative Spaces: Strategies and Challenges

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Abstract

Introducing new collaboration tools in an organization is difficult and will most often cause side-effects and unforeseen consequences. In this paper we use the concept of Common Information Spaces (CIS) to analyze how information is shared within a large organization. We draw on findings from a large, international oil and gas company to analyze the implementation of a Microsoft SharePoint based collaboration system within the organization. Analytically we discuss the drifting nature of large-scale efforts to establish a company-wide centralized and tightly integrated CIS. Acknowledging that introducing information systems that instigate changes in work practices are inherently difficult within any organization, and even more so in large enterprise organizations, combined with the diversified perspectives on how to establish CIS within the existing literature we characterize large-scale common information spaces and identify directions for further research.

1. Introduction

Today, organizations have to transfer information and share knowledge across geographical and organizational boundaries. It is widely assumed that integration of a fragmented infrastructure is a prerequisite rather than an option to achieve such vision. Despite the existing variety of technological techniques [11], integration activities tend to display emergent properties [29]. According to Kuldeep et al. [8, p.23] “integration has been the holy grail of MIS since the early days of computing in organizations”. This argument is continually supported with empirical studies from various industries, such as health care [5], ship classification [21], e-government [3], and oil and gas industry [12].

In this paper we employ the concept of common information space (CIS), which is extensively used within the field of Computer Supported Cooperative Work (CSCW) to analyze how actors jointly construct various socio-technical arrangements in order to share information across organizational boundaries. The crucial aspect of CIS is not a seamlessly integrated technological environment, but continuous interpretation work [22].

Consequently, the concept challenges taken-for-granted assumptions of achievable seamless integration: “the notion of ‘a uniform, complete, consistent, up-to-date integration’ of the knowledge in a community handbook is hardly realistic” [22, p.24]. As such, the concept enables analyzes of how integration activities unfold in practice.

Our research is motivated by a recent call to explore the dynamics of large-scale common information spaces [20]. We draw on diverse literature on CIS and discuss such aspects as the role of interpretation work [22], openness and closure [1] and heterogeneity [2]. Additionally, we discuss the nondeterministic character of IS implementation processes [19] and how initial plans drift in practice [4]. Furthermore we adopt the concept of *uncertainty*, which derives from a recent contribution by Latour [9]. The author vividly conceptualizes inherent uncertainties stemming from an endless web of mediators, where mediators “transform, translate, distort, and modify the meaning or the elements they are supposed to carry” [9, p.39]. We use this concept to expose and discuss inherent uncertainties, rather than rational planning with predictable consequences, in establishing large-scale CIS.

Empirically we illustrate integration activities within a large international oil and gas company (dubbed OGC). Our research is part of a larger, internal OGC project aiming at improving oil and gas production optimization activities. We zoom-in and unpack the (re)establishment of the collaborative infrastructure. The old collaborative infrastructure was based on Lotus Notes technologies and aimed to increase organization-wide standardization and cost-effectiveness [13]. This vision resulted in more than 5000(!) unsynchronized databases and an even more fragmented infrastructure. In order to increase consistency, remove fragmentation and ease both information retrieval and sharing, a new collaboration strategy was launched. The material outcome of this strategy was the implementation of a new collaborative infrastructure based on Microsoft SharePoint technologies. Findings from our ongoing research suggest that the new infrastructure constrain institutionalized work practices and tend to produce side effects [14]. Thus, the main purpose of this paper is to characterize large-scale common information spaces in an oil and gas company, and identify directions for further research.

The paper is organized as follows: We start off with a brief description of the history of CIS and identify some important contributions in the area. We then look into some possible problems that can arise when introducing new information systems, that is, unforeseen consequences, before we investigate the role of plans and strategies when introducing new IS tools. Then an outline of our research approach follows, before we introduce the case in context. Following this is a discussion of the case in contrast to the existing literature before we round off with a brief section describing our future research direction as well as a few concluding remarks.

2. Conceptualizing common information spaces

The concept of common information spaces was originally formulated by Schmidt and Bannon [22] to bring focus on an area of “critical importance for the accomplishment of many distributed work activities” [22, p.16] as they believe the area has been neglected within CSCW. CIS is offered as an alternative to the so-called ‘workflow’ perspective, where every actor’s actions can be predefined in advance. The authors draw on Suchman [25] and highlight that in contexts where continuous negotiation and problem solving is required, ‘workflow’ perspective fails to explain how work is done in practice. Consequently, they argue for an alternative approach, which would “allow the members of a cooperating ensemble to interact freely” [22, p.20]. They argue that cooperative work is not facilitated merely through access to information in a shared database, but also require a shared understanding of the meaning of this information, as the information always has to be interpreted by human actors. Then they introduce the concept of common information spaces, which seeks to explain how people in a distributed setting are able to work cooperatively through access to common organizational information and a shared understanding of the ‘meaning’ of this information: “a common information space encompasses the artifacts that are accessible to a cooperative ensemble *as well as* the meaning attributed to these artifacts by the actors” [22, p.21]. While interpretation work and construction of a particular object’s ‘meaning’ is situation dependent, and determined locally within a given context, the coherence is crucial: “in order for work to be accomplished, these personal, or local information spaces must cohere, at least temporarily” [22, p.21].

Bannon and Bødker [1] build on this concept and investigate the dialectic nature of CIS. They acknowledge that there are many forms of common information spaces. Sometimes common information spaces are comprised of people working at the same time and place, while other times people collaborate across both time and space boundaries. Though there are various forms of CIS, they recognize that common information spaces have some common identifying properties. In order to conceptualize

large-scale CIS authors draw on science and technology studies (STS) and identify such concepts as ‘immutable mobile’ and ‘boundary object’, which “both can be viewed as being concerned with how communities develop means for sharing items in a common information space” [1, p.84]. Additionally, authors highlight the relevance of the “community of practice” perspective developed by Lave and Wenger [10] in order to indicate learning and working environments. The central issue then becomes whether information should be circulated within or across communities of practice. In other words, to what extent local information should be malleable and at the same time ‘packaged’ to have a ‘common’ meaning in different contexts. Following these conceptualizations Bannon and Bødker [1] identify the dialectical nature of CIS:

“It is this tension between the need for openness and malleability of information on the one hand, and, on the other, the need for some form of closure, to allow for forms of translation and portability between communities, that we believe characterizes the nature of common information spaces, and leads to difficulties in their characterization. CISs are both open and closed – in a word, they have a dialectical nature” [1, p.85]

Bannon and Bødker [1] illustrate the dialectical nature of CIS with several empirical examples. At one end of the spectrum they discuss coordination rooms where co-located actors manipulate malleable CIS. At the other end, they expose a heterogeneous large-scale CIS, the WWW, inherently uncertain and dialectical.

Bossen [2] proposes a refinement of the concept of common information spaces and proposes a conceptual framework to analyze cooperative work. His framework is developed through the analyses of CIS in a hospital ward and results in the identification of 7 parameters he argues is useful in order to position a given CIS. Bossen acknowledges that “it is doubtful whether it will be possible to generate a distinct categorization, i.e. typology, through which specific work settings can be categorized into particular types of CIS” [2, p.185]. He therefore suggests, “it might be better to have a framework through which specific settings can be analyzed” [2, p.185].

Randall [18] is critical to the idea of commonality within CIS. He claims that “the very notion of CIS is radically underspecified” [18, p.17] as, he continues, “it is not possible to distinguish its putative features by reference to technology, to information or to organizational structure” [18, p.17]. The problems with classifying CIS occur in part because CIS ranges “from shared, small groups to complex inter-organizational chains” [18, p.17]. Because “we have to deal with issues that arise out of the complex historical and geographically dispersed range of information resources that might be in use in the large organization, or indeed across different

organizations” [18, p.17], it is problematic to identify exactly what is common across various work practices.

Rolland, Hepsø et al. [20] conducted a study of different common information spaces in a major international oil and gas company as well, and their findings suggested that some common information spaces appear to be more situated, momentary and malleable when embedded within an extremely heterogeneous context. They end their paper by acknowledging the “need for more research on large-scale collaborative systems in order to improve current conceptualizations of CIS” [20, p.499]. This is because “most studies within CSCW have been focusing on relatively small-scale systems involving a limited group of users collaborating over small distances” [20, p.499].

3. Research approach and data collection

In our ongoing research project we are aiming to study the transition process from Lotus Notes to MS SharePoint technologies in OGC. We are studying both technological and social complexity and investigate “the interaction between the engineering detail of the technical systems and the related dynamics of the surrounding social arrangements” [4, p.3]. We conceptualize our research as an interpretive case study [26] as we do not predefine dependent and independent variables and “attempt to understand phenomena through the meanings that people assign to them” [7, p.69].

We conceptualize our research design as emergent rather than highly structured. We lean towards an inductive approach and identify grounded theory [15] and ethnography-informed [24] studies as relevant approaches to explore IS implementation activities in real-world contexts, and build our theoretical perspectives on empirical data, rather than analytical constructs.

Data collection and fieldwork started in the beginning of 2007. Since then, we have conducted seven interviews with OGC representatives, who mainly represent the so-called management perspective. The interviews lasted from one to several hours. The first interviews were more open-ended with the primary focus on current OGC initiatives and plans regarding the use of MS SharePoint technologies. Latter interviews were more focused on both technological complexity and interdisciplinary work practices. Besides that, we have extensively studied various documents, including project plans, reports, various presentations and other related documentation. More than 300 pages were gathered and carefully analyzed. Additionally, we’ve had the opportunity to study several email discussions related to project planning and execution activities. Recently, we have also been granted access to an extensive information source of OGC activities – the intranet portal. The content of the studied documents and conducted interviews have introduced us to the existing socio-technical complexities, main strategic initiatives with expected deliverables and current

problems. Previous studies on implementation and use of Lotus Notes in OGC [8, 14-18] were also carefully studied and analyzed in comparison with current problems and challenges.

Further data collection activities will involve document analysis, participant observation and semi-structured interviews. We aim at obtaining in-depth knowledge of both surrounding socio-technical contexts and the diverse perspectives of various actors.

4. Case description

Introducing new systems for computer supported collaborative work is a complicated task in all organizations as it not only introduces new IT tools, but also new ways of working [16]. What makes this even more difficult in large organizations is that they have so many different people working on so many different tasks at a number of different locations. Introducing one single system to support all users at all tasks in all locations is a major challenge.

In 2001, OGC, a major international oil and gas company, that today has about 26 000 employees in 34 countries worldwide, formulated a strategy to improve collaboration within the organization. This strategy focuses on collaboration within the company, and ranges from so-called collaboration rooms, which are dedicated rooms where experts from various disciplines meet, to systems like video conferencing for collaboration between users at various locations to more traditional collaboration ICT-systems. Collaboration can take place between users at the same or different location, and at the same or different time. People wishing to collaborate at the same time can choose to use the collaboration room if they are all at the same location, or they can use a video conference system if they are located at two or more locations. If they want to collaborate at different times – maybe because they are dispersed around the world in different time zones – they can use a more traditional collaboration system.

One of the results of the strategy was the decision to change the collaboration infrastructure. This decision was made in 2003. OGC had up until then been using a system based on Lotus Notes, but after considerable research it was decided to discontinue the use of Lotus Notes and instead implement a new infrastructure based on Microsoft SharePoint technologies. It was believed that this new infrastructure would better suit the management’s vision of collaboration within the organization. In addition, the introduction of this new information system was used to catalyst an organizational change.

Due to the size of the organization, as well as the nature of the business, each month OGC creates about 70 000 Word documents, 65 000 Excel spreadsheets, 20 000 PowerPoint presentations and 145 000 non-classified documents. That is about 300 000 new

documents each month. Keeping track of all these documents require a robust and scaleable system.

The old Lotus Based collaboration system had a few aspects that were considered unfortunate. First, the Lotus Notes infrastructure had grown out of control. In total the system consisted of more than 5000 different, dispersed Arena databases for document storage. The Arena databases had no central indexing functionality, meaning that it was impossible to retrieve a document by searching if you did not know which database to search. Each user had in addition access to both personal and departmental storage areas. Not all users chose to store their documents in the Arena databases, but instead chose to store it on either of the aforementioned storage areas. This meant that even if it had been possible to search all databases at once, it would not have been successful as not all documents were stored in the databases.

Implementing the Microsoft SharePoint technology was hoped to change the way people worked. According to the strategy, OGC already had a set of general collaboration tools, but “these tools are poorly integrated”, and “there is a particular need for better and more integrated coordination tools, better search functionality and improved possibilities for sharing information with external partners”. (internal strategy documents). The strategy defined the main challenges to be addressed by the new solution to be “information quality, archiving, search/retrieval and proper handling of e-mail”. It was believed that the real benefit of introducing the new infrastructure was that it would change the way people worked. They would work more efficiently. The company acknowledged that introducing the new information system was just a minor part of the strategy. More important was the change of work practices. In one document they emphasize this by claiming that the new strategy would be “80% change - 20% IT” (internal strategy document).

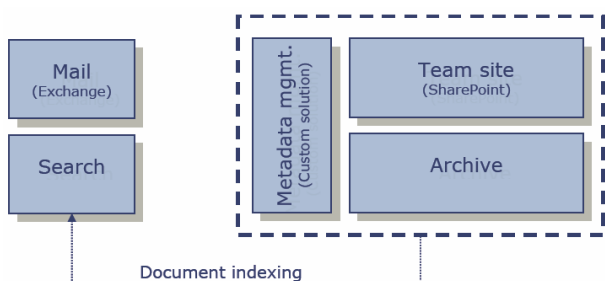


Figure 1: Integration of collaboration tools

As indicated by figure 1, MS SharePoint is, together with the metadata management system and the archive, a core element of the new collaboration solution. This solution would then be integrated with OGC’s email

system, and their in-house search engine. MS SharePoint is a collaboration system that in addition to being a repository for storing and retrieving documents also has functionality for checking-in and checking-out documents and version tracking; it has web-based discussion boards, as well as features for managing wikis. MS SharePoint can also be linked to email-systems and MS Live Messenger (previously MSN Messenger) for instant messaging.

Central within MS SharePoint is the concept of *Team Sites*. A Team Site is a virtual workspace shared by people working on the same project, in the same department, within the same discipline, etc. The average user will typically be a member of a handful different Team Sites. Typically a Team Site has a limited lifetime and is oriented around a specific task; for instance drilling of a given well. All documents related to the drilling of this well is gathered within this Team Site.

When a project is initiated the project leader will typically have a Team Site created. When creating a Team Site the project manager has to define a set of applicable metadata from a list of available values. The metadata would typically be selected based on what kind of task for which the Team Site was created. When uploading documents to the Team Site later, the members would have to assign metadata from the selected set to the documents to classify the documents for easier retrieval. This use of metadata is not a standard feature of MS SharePoint, but a custom feature added by OGC to give added value. As we will later discuss, this is also a source of problems when using MS SharePoint at OGC.

Today, there are three levels of metadata at OGC. Originally there were only two levels. But a third level was added to try to combat the problems that occurred. The two first layers only allow users to select values from a predefined list using drop-down boxes. The third level uses free text fields, allowing users to define the values they feel appropriate for a given document.

5. Analysis: introducing uncertainties

Given our case at OGC we’ve been studying relevant literature within the areas of CSCW and integration to assign meaning to, and build an understanding of, the context. While digging down into the case we have been alternating between understanding the context based on literature, and letting our findings guide our literature search. Through this process we’ve come up with 5 characteristics of large-scale common information spaces that will guide our further research.. These characteristics are described in more detail in the following sections. A summary of these characteristics can be found in table 1.

Tensions	Characteristics of large-scale CIS in OGC	Further research considerations
Common space or spaces	Overlapping interdependent CISs	Is it possible to establish one centralized and tightly integrated large-scale CIS in global organization?
Objects or socio-technical arrangements	Fluid and continually negotiated socio-technical arrangements	What ‘common’ properties should various collaborative technologies have to enable effective collaboration between different disciplines?
Flexibility or closure	Closure and minimum flexibility in local contexts	How can organization achieve flexibility in use and closure in compliancy with internal and external regulations?
Top-down or bottom-up	Top-down initiative imposing rigid data classification standards	How, when and to what extent should bottom-up or top-down approaches be employed when implementing large-scale information systems?
Heterogeneity or homogeneity	Heterogeneous and discipline-specific technologies	Can working and effective large-scale CIS be achieved with homogeneous technologies?

Table 1: Summary of findings

5.1. Common space or spaces?

According to OGC’s strategy the company wishes to implement a single, common collaboration tool, namely a system based on Microsoft SharePoint technologies. They have developed ‘Best practice’ directives and guidelines for the use of this new system seeking to create a consistent usage of the tool throughout the organization. We can look at the use of Microsoft SharePoint as a collaborative tool from two different angles; either it is believed that the entire OGC organization with all employees, tools and equipment is one huge common information space that everyone is a part of, or that OGC consists of a vast number of smaller common information spaces that all have the new CSCW tool in common. Consequently, we ask if it is possible to establish one centralized and tightly integrated large-scale CIS in global organization.

Suggesting that OGC consists of one single CIS is problematic as it to some extent would imply that all employees have significant aspects of their work in common. In a large, heterogeneous organization like OGC this is at best doubtful. Exactly how much does a geologist’s work have in common with the work of a production engineer? Or what does the IT department have in common with Human Resources?

As this seems difficult it is more reasonable to assume that OGC consists of a vast number of different common information spaces. That is, for instance, production engineers have one view of the work situation

while geologists have a completely different view. The common information spaces at OGC, we suggest, are in many ways similar to the situation in an airport, as described by Fields, Amaldi et al. [6, p.21]. They found that they could “regard the airport not as a CIS but a constellation of overlapping interdependent CISs that are articulated through boundary objects” [6, p.21].

5.2. Objects or socio-technical arrangements?

Common information spaces can be seen from two different perspectives: Either 1) as a boundary object; or 2) as a socio-technical arrangement. Boundary objects are “entities that are interpreted differently in different communities of practice, yet are stable enough to retain their integrity as objects, thus facilitating working across the boundaries between different communities” [6]. That is, boundary objects are both flexible enough to allow local interpretations, as well as rigid enough to be similarly enough understood in different communities of practice. This way boundary objects can mediate between different communities. From the socio-technical perspective, a “CIS is not simply a boundary object for different communities of practice, but a socio-technical arrangement that only temporarily on specific occasions are practiced in such ways that give a momentary common understanding” [20, p.494]. This latter perspective, Rolland, Hepsø et al. [20] argue, is particularly relevant when introducing CIS across heterogeneous contexts, where “sharing and negotiating

common understanding are much more temporary and fluid than the term boundary object suggests” [20].

In our context, the Microsoft SharePoint technology in OGC can be considered a boundary object, where all users have a similar understanding of what this new tool is, even though they do very different work and uses very different terminology in conducting their daily work. Using the technology, on the other side, can be seen as a socio-technical arrangement where different users interpret and use the technology in different ways in different situations. For instance, a user can utilize the same technology in different ways in different projects or at different times. As a result, we inquire what ‘common’ properties various collaborative technologies should have to enable effective collaboration between different disciplines.

5.3. Flexibility or closure?

As mentioned, Bannon and Bødker [1] explore the dialectic nature of openness and closure within CIS. The openness refers to the flexibility and malleability of CIS and indicates the desire for flexible and malleable information systems. Of course most users would prefer such a system when producing information as they would not have to make specific adjustments like special formatting or meta-tagging to upload their information into the system. The system would be able to handle anything.

The old Lotus Notes-based system appears to have had a large degree of this freedom. After all, by the end the system consisted of about 5000 different databases. If a given piece of information did not fit into the existing databases one would simply create a new database fitting ones requirements.

But to the management of OGC this solution is not satisfactory. It is inefficient; both with regard to workers having to do the same work again as they cannot find documentation of others having already done it, and with regard to storage utilization as the same information is stored more than once.

In the new Microsoft SharePoint based infrastructure users would have a more rigid solution. Information would have to be assigned meta-tags and keywords before they could be uploaded. The benefits of this are not necessarily obvious to the average user, and there is the risk that users simply add more or less meaningless meta-tags and keywords.

As mentioned in a previous section, the use of metadata was the cause of problems and frustration among users. The main problem, according to one of our interviewees (a leading engineer), occurred when establishing new Team Sites. It was very difficult to select an appropriate set of metadata up-front, that is, it is difficult to select the appropriate metadata values before one knows what kind of information that will actually be stored in the Team Site. The metadata selected when

creating the Team Site were the metadata members of the Team Site would have to choose from when uploading information. Another part of the problem was that no two people would ever select the same set of metadata if they where to create the same Team Site. The available set of metadata would therefore be dependent on who created the Team Site. As human beings are inconsistent creatures, the same person would also probably select one set of metadata one day and a completely different set the next day. According to our informants, users of SharePoint feel that these problems manifest themselves in the daily use of the technology, which caused a source to compare using SharePoint and Team Sites with “conducting an extreme sport”.

Another problem with the use of metadata is that the various members of the Team Site have to classify their documents when uploading them. One source commented that they were engineers, and that people study library science for several years to learn to classify information. This is an area that further research will investigate more thoroughly.

Balancing the organization’s need for standardized and strict solutions against the users’ wish for flexible and open tools we believe is an important area of research that we wish to look deeper into. Accordingly, we ask how to achieve flexibility in use and closure in compliancy with internal and external regulations.

5.4. Top-down or bottom-up?

There is a long tradition to promote participatory design as a way to reduce the design-use gap [23]. This approach represents so-called bottom-up patterns and requires active users’ involvement in various development and maintenance activities. While the benefits of such methods are widely recognized, we wonder how effectively it functions in large-scale projects. For instance, in a recent contribution Ellingsen and Monteiro [6] illustrate how the ambition of seamless integration unfolds over the time. The authors present integration activities in a large-scale health care context and illustrate how ordering activities in one context produce disorder in other contexts. Consequently, they question the appropriateness of participatory design in large-scale contexts: “...truly user-led development is impossible to achieve in large-scale integration projects. Furthermore, this increases the possibilities for unintended consequences and disorders...” [6]. This conceptualization underscores that unintended consequences are inherent, and participatory design techniques will hardly eliminate them. The question then remains to what extent participatory design should be cultivated.

Considering implementation and use of collaborative technologies in OGC, we identify a similar tension as well. For instance, with the previous collaborative infrastructure (Lotus Notes) local actors had the ability to

participate in the constitution and maintenance of their local information spaces. However, the new collaborative infrastructure based on MS SharePoint technologies imposes quite rigid information classification standards, which reduces the local actors' ability to modify local spaces according to their needs. Such change illustrates movement from active participation to compliance. Being aware that truly user-led development and maintenance activities in such scale (over 25.000 actors) are hardly possible, we wonder how to balance the local needs with company-wide standards.

In OGC, the implementation of MS SharePoint has not given the users any opportunity to participate in the development process. It was in large a managerial decision to replace the old infrastructure with a new one. With regards to user participation, it was the definition of the metadata set that involved users, that is a few persons in managerial position within the various disciplines and departments in the organization. The average user has had no way to influence the implemented system.

We do as of now not have any data that suggests that the lack of user involvement during implementation is the cause of the problems OGC has had with metadata and classification, but nevertheless, they do have a problem with these issues. When questioned about what it would take to make the users satisfied with the system, one of our informants (a manager within the IT department) simply answered: "I don't think it's realistic to make the users satisfied". He then stressed that he to some extent said this to provoke, but that there were an element of truth in what he said. This illustrates the difficulties of catering to such a large group of users: No matter what you do, you can't make everybody happy! Therefore, we ask how, when and to what extent bottom-up or top-down approaches should be employed when implementing large-scale information systems.

5.5. Heterogeneity or homogeneity?

In theory, the constitution of CIS is quite explicit and clear, it encapsulates both actor-networks [9] and human enacted structures [21]. An interesting and more attention gaining aspect of CIS is heterogeneity. We conceptualize our research context as extremely heterogeneous [20], but for analytical purposes, we do not discuss the whole context as such, we zoom-in and unpack only a technological actor – collaborative technologies – MS SharePoint and Lotus Notes at OGC.

Both technologies are to some extent homogeneous. They cut across organizational boundaries and impose particular patterns of use. However, MS SharePoint technologies, as outlined above, are more rigid. Additionally, it is an integrative technology, which seamlessly integrates with other Microsoft products. Thus, MS SharePoint can be conceptualized as a large-scale homogeneous and integrated monolithic structure,

while Lotus Notes is more flexible and customizable to local needs.

Drawing on a recent conceptualization on CIS [20] in heterogeneous contexts, we inquire whether working and effective CIS can be achieved with homogeneous technologies. As illustrated by Rolland et al. [20] arrangements of heterogeneous technologies tend to be more effectively exploited in cross-discipline collaborative environments.

6. Conclusions and further research directions

Our research findings suggest that integration is an inherently complex process involving continuous negotiations between various human and non-human actors. Both technical [29] and socio-technical [4] studies report that integration efforts tend to drift from the initial plans and produce various side effects. Drawing on an interpretive field study in OGC we have identified the uncertain and drifting nature of CIS as well. In our case, ambitions to establish an 'out of the box', centralized and tightly integrated collaborative infrastructure produced side-effects and invoked the development of custom components, which aim to increase flexibility for the end user. As recently outlined by Ellingsen and Monteiro [6], ordering in one context tend to produce disorder in other contexts. This aspect can also be supported with the recent conceptualizations that actions are continually other-taken [9]. Such conceptualization emphasizes uncertainty and dynamics of use when technologies are put to use. Ambitions to eliminate particular tensions (as discussed in section 5) are rather subjective, because it is difficult or perhaps hardly possible at all to test or evaluate how a particular configuration will function later on.

Our ongoing research suggest that large-scale CIS is composed of smaller overlapping common information spaces containing heterogeneous collection of socio-technical arrangements that need to be continually (re)negotiated by the actors involved. These findings challenge the assumption that large-scale centralized and tightly integrated, rather than distributed and fragmented, CIS can be achieved in large-scale contexts.

Considering that this paper reports early research findings our further research activities will explore the questions identified in the discussion section, aiming to get in-depth knowledge on implementation and use of collaborative technologies in OGC.

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